

**REMARKS**

Applicants respectfully request reconsideration and allowance of all pending claims.

**I. Status of the Claims**

Upon entry of this amendment, claims 1-7, 17, and 65-69 remain pending. Claims 70-73 are new. Claims 1, 17, and 65 have been amended.

Support for the amendment to claims 1 and 17 with regard to the increased chloride and sulfur content can be found in applicants' specification at [0024] and [0026] of applicants' published application (2004/0168343).

Claim 65 has been amended to overcome the claim objection stated on page 7 of the Office Action mailed 1/3/2006.

Independent claims 1 and 17 have been amended, and new claims 70-73 have been added, to underscore the aspect described in paragraphs 0024 and 0026 of intentionally increasing the chloride and sulfur impurity level in the deposit.

**II. 35 U.S.C. §103(a) Rejection of Claims 1-7**

Reconsideration is requested of the rejection of claims 1-7 as being obvious over Barstad et al. (U.S. 6,444,110) in combination with Creutz et al. (U.S. 4,110,176).

Claim 1 includes the requirement of a defect-reducing agent which is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine... which results in an increase in sulfur and chloride content in the deposit.

The cited references do not render applicants' claim 1 obvious because (A) they do not disclose or suggest the requirement of including an additive and otherwise electroplating under conditions which increase the chloride and sulfur content of the deposit, and (B) there is no motivation to

use the "brightening agent" from Creutz et al. in the electroplating baths described in Barstad et al.

**A. The cited combination does not disclose or suggest all the elements of claim 1 (or new claims 70-73)**

Claim 1 requires use of an effective amount of a reaction product of benzyl chloride and hydroxyethyl polyethylenimine to increase the overall chloride content and the overall sulfur content of the copper deposit. New claims 70-73 require that the sulfur content is at least 1.5 and  $3 \times 10^{18}$  atoms/cm<sup>3</sup>. Applicants' specification at paragraphs [0024] to [0026] discusses the increases in impurity contents resulting from the addition of claim 1's defect reducing agent.

Neither Barstad et al. nor Creutz et al. discuss problems related to creep deformation or the advantages which could be gained from purposefully introducing chloride impurity in the copper deposit. It is not surprising that Creutz et al., directed to plating through holes in PCB substrates, do not discuss the problem because creep deformation is not a serious problem in copper in through holes in PCB substrates. Moreover, they state that chlorine concentration in the bath should be kept low:

"Although it has been found to be desirable that chlorine and/or bromide anions in the bath are below about 0.1 gram per liter, appreciably greater amounts of many inorganic cations, such as ferrous iron, nickel, cobalt, zinc, cadmium, and the like, may be present in the bath ...."

Similarly, Barstad et al. are silent, or even in some respects teach away from including a component in their copper electroplating bath which purposefully introduces impurities in

the copper deposit where they express a preference for plating copper which has an absence of "...voids, **inclusions**, and seams)..." See Col. 2, lines 36-42 of Barstad et al.

Moreover, while it may be tempting to conclude that the proposed combination of Creutz et al. and Barstad et al. would have *inherently* increased the chloride and sulfur content of the deposit, this cannot fairly be maintained in view of the disparate nature of the respective teachings as to how the particular reaction product is used. In particular, Creutz et al. added the reaction product in a quantity of just 0.5 mg/L (Example II, col. 6, line 12). Examples III and IV used only 1 and 0.4 ppm of the reaction product. There is no indication this would increase the chloride and sulfur content of the deposit as required by claim 1, or increase the sulfur content to at least the specific amounts required in claims 70-73.

For a property to be deemed to be inherent, the Office must establish by fact or technical reasoning why it is *necessary* that the Creutz + Barstad combination would inherently increase chloride and sulfur content in the deposit as in claims 1 and 70-73:

*Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient. (MPEP 2112 (quoting In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999))) (emphasis added).*

In relying on the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily* flows from the teaching of the applied prior art. (MPEP 2112 (citing Ex parte Levy, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990))) (emphasis added).

In the present situation there is no technical basis to make this conclusion in view of the lack of any statement by Creutz et al. that they increased chloride content and in view of the low quantities in which the reaction product was added.

In further support of patentability, applicants note that their increase in impurity content as described in claims 1, 17, and 70-73 has resulted in a process with unexpectedly superior defectivity properties in that the incidence and severity of defects is substantially decreased.

Claims 2-7 depend from claim 1 and are patentable for the same reasons as claim 1 and by virtue of the additional requirements therein.

**B. There was no motivation to make the Office's proposed combination.**

Barstad et al.'s electroplating baths contain the following primary ingredients:

- a) copper sulfate
- b) sulfuric acid
- c) chloride ion
- d) a suppressor
- c) a divalent sulfur brightener.

See Examples 1 and 2 at Col. 18 of Barstad et al. In addition to the above primary components, Barstad et al. stated that use of a leveling agent is "generally preferred," such as "leveling agents ... described and set forth in U.S. Pat. Nos. 3,770,598, 4,374,709, 4,376,685, 4,555,315 and 4,673,459."

The basis for the rejection is the Office's assertion on page 5 of the final Office action that Barstad et al.'s Examples

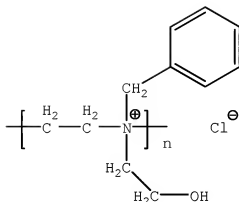
1 and 2 employ a brightener, and Creutz et al. disclose the relevant polyethylenimine reaction product and call it a "brightening agent," so one would have been motivated to substitute the Creutz et al. polyethylenimine reaction product into the compositions of Barstad et al.'s Examples 1 and 2 in column 8.

Applicants respectfully request reconsideration because the Creutz et al. "brightening agent" is so wholly distinct from the Barstad et al. "brightener" in terms of character and function that one skilled in the art would not be motivated to select, and would in fact avoid selecting it, as a substitute for the Barstad et al. "brightener." There would have been no reasonable expectation of success. One skilled in the art would therefore not consider it to be a suitable substitute for the Barstad et al. brightener, despite the superficial similarity between the assigned terms "brightener" and "brightening agent."

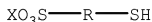
More particularly, in describing their "brightener," Barstad et al. state that "typical brighteners contain one or more sulfur atoms" and many species containing an -S-S- moiety are presented as preferred. Col. 5, line 5 ff. In fact, the Examples 1 and 2 relied on by the Office used bis-sodium-sulfonopropyl-disulfide (col. 8, lines 15 and 45). This is a "primary brightener" as was well known in the art. The Barstad et al. invention centered on increasing the concentration of this brightener:

As discussed above, it has been discovered that by increasing brightener concentration beyond conventional levels, uniform plating of particularly high aspect ratio microvias and other difficult-to-plate apertures is now possible. Col. 4, lines 43 ff.

The polyethylenimine reaction products described by Creutz et al. have the following structure:



Which contrast sharply with the structure of the brighteners contemplated by Barstad et al.:



where in the above formulae R is an optionally substituted alkyl group, and preferably is an alkyl group having from 1 to 6 carbon atoms, more preferably is an alkyl having from 1 to 4 carbon atoms; Ar is a substituted aryl group such as optionally substituted phenyl or naphthyl; and X is a suitable counter ion such as sodium or potassium.

Their disparate structures are manifested in their disparate functions. The Creutz et al. reaction product functions by leveling as is evident from comparison of Creutz et al's Examples I and II: "uneven" v. "even and had improved leveling." In contrast, the well known brighteners of the type to which Barstad et al. refer function by grain refinement.

Accordingly, one motivated to modify the Barstad et al. process by substituting in a different brightener would not be motivated to substitute in the polyethylenimine reaction product described by Creutz et al. Moreover, the brightener in the Barstad et al. patent is the key component, i.e., the component which they assert to have discovered gives "uniform plating of particularly high aspect ratio microvias and other difficult-to-plate apertures" if increased in concentration. Against this background, one would not make the proposed substitution lightly.

Furthermore, in view of the disparate structure and function of the Creutz et al. compound from the Barstad et al. brightener, there cannot fairly be deemed to have been any reasonable expectation the substitution would have been successful. Barstad et al. purported to have discovered this special capability of brighteners in superfilling "difficult-to-plate apertures." The brighteners they describe are the traditional disulfide type of primary brighteners that function by grain refining. On what basis would one skilled in the art be able to reasonably conclude that the differently structured and differently functioning Creutz et al. compounds would work? In fact, there is no reasonable basis to expect success, especially considering the unpredictable nature of complex performance chemistry. As emphasized in MPEP 2143.02, an obviousness rejection cannot be maintained if there is no reasonable expectation the proposed modification would be successful.

In view of the foregoing, there is no motivation to substitute the polyethylenimine reaction product of Creutz et al. into the Barstad et al. process to arrive at the electroplating method defined by applicants' claim 1.

Accordingly, the combination of references fails to render claim 1 obvious, and applicants' request withdrawal of the rejection.

**III. 35 U.S.C. §103(a) Rejection of Claim 17**

Reconsideration is requested of the rejection of claim 17 as being obvious over Barstad et al. (U.S. 6,444,110) in combination with Creutz et al. (U.S. 4,110,176).

Claim 17, similarly to claim 1, is directed to a method of electroplating a copper deposit by superfilling into interconnect features from an electroplating bath comprising "...a suppressor, an accelerator, and an effective amount of a defect reducing agent, wherein the defect reducing agent is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine... ." Moreover, the defect reducing agent increases the chloride ion content of the copper deposit as compared to a comparable electroplating bath not containing the defect reducing agent. Accordingly, claim 17 is patentable for the substantially the same reasons as claim 1.

**IV. 35 U.S.C. §103(a) Rejection of Claims 65-69**

Reconsideration is requested of the rejection of claims 65-69 as being obvious over Barstad et al. (U.S. 6,444,110) in combination with Creutz et al. (U.S. 4,110,176).

Claims 65-69 depend from claim 1 and are patentable for the same reasons as claim 1 and by virtue of the additional requirements therein.

For example, claims 67, 68, and 69 require concentrations of the defect reducing agent of 1.0 mL/L, 2.0 mL/L, and 5.0 mL/L, respectively. Barstad et al. do not disclose these concentrations because they disclose leveler concentrations from 0.05 mg/L to 0.5 mg/L. See Col. 7, lines 17-19. Creutz et al. do not disclose these concentrations because they disclose



leveler concentrations of 0.5 mg/L in Example II and 0.4 PPM (0.4 mg/L) in Example IV.

**V. New Claims 70-75**

Claims 70-72 depend from claim 1 and are patentable for the same reasons as claim 1 and by virtue of the additional requirements therein.

Claims 73-75 depend from claim 17 and are patentable for the same reasons as claim 17 and by virtue of the additional requirements therein.

All of these claims are directed to chloride contents in the copper deposits electroplated from a bath comprising the defect reducing agent described in claim 1. These claims are patentable because neither Barstad et al. nor Creutz et al. disclose a chloride content in their copper deposits.

**CONCLUSION**

In view of the foregoing, applicants request reconsideration and allowance of all pending claims.

The Commissioner is hereby authorized to charge the fee for the two-month extension in the amount of \$450.00 to Deposit Account No. 19-1345. The Commissioner is hereby authorized to charge any additional fees which may be required to Deposit Account No. 19-1345.

Respectfully submitted,

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